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REPORT OF THE COMMITTEE TO RECOMMEND A SUITABLE PROGRAM IN MATHEMATICS FOR THE JUNIOR HIGH SCHOOL.

This committee was appointed by the president of the Association of Teachers of Mathematics in New England at the spring meeting, May 1, 1917. A preliminary meeting of the committee was held on May 15, 1917. The committee, now seven in all, has members from two large general high schools, one public technical high school, one public grammar school, and two private preparatory schools; it also has as a member one assistant superintendent of schools.

The committee held eight meetings at intervals of about four weeks, and one meeting in October, 1918. At no meeting were there more than two members absent.

The definition of the junior high school which the committee adopted was the three years commonly called the seventh, eighth and ninth, thus including what is now the first high school grade.

The deliberations of the committee may be divided into four parts.

I. The discussion and adoption of the aims of the mathematical course of the junior high school.

II. The discussion of topics for such a course, and the justification of each topic as a factor in realizing these aims.

III. The formation of these topics into a logical and teachable course.

IV. The discussion of the limitations and the interpretation of the meanings of the topics.

I. Aims.

After an extended discussion of the question, the committee adopted five general or cultural aims and five specific or utility aims, as follows:

A. General or Cultural Aims.

1. To develop habits of concise, exact, and logical thinking and expression.

2. To develop self reliance.
3. To develop a sense of personal responsibility.
4. To develop an ability to apply general principles to new problems.
5. To inculcate some appreciation of the influence which mathematics has had on the great sciences and industries of the world.

B. Specific or Utility Aims.

1. To produce accuracy in computation.
2. To produce reasonable speed in computation without sacrificing accuracy.
3. To develop a definite idea of number values.
4. To develop an ability to recognize the degree of accuracy possible with measured data.
5. To develop the ability to handle a variety of mathematical tools.

The committee feels that the definite nature of the three years covered by this course when considered as a period in the child's school career, makes it especially desirable that a program be planned that shall have a great degree of unity and very definite aims. These three years come at a time when many children are planning to leave school in a few years at most. The unity and completeness of the mathematical program will have its effect in keeping the child in school until the end of these three years. Hence an attempt has been made to formulate aims the accomplishment of which can be reasonably hoped for from a well-organized course in the beginnings of mathematics.

The general or cultural aims are statements of five general qualities which it should be the purpose of any course in elementary mathematics to develop. The specific or utility aims are the statements of five qualities of mathematical ability which the mathematical course of these particular three years should be expected to develop in the pupil.

The much debated question of whether any general abilities can be developed through the study of a particular subject need not be settled in order to justify these general aims. For our purposes, the widely accepted conclusion that acquired abilities can be transferred "with some loss" to fields in which similar elements exist is a sufficient reason for hoping to accomplish these aims. We do not hope to develop habits of concise, exact, and logical thinking and expression for all children in all lines of thinking. We do not hope to develop self reliance or a sense of personal responsibility for every child in all of his fields of activity. If the training which he receives from his mathematical studies increases his ability to think logically and rely on himself in a few related fields, we are justified in keeping these qualities prominently before the teacher by formulating them as aims the accomplishment of which is desirable. The application of general principles to new problems and the appreciation of the influence which mathematics has had in the world's development are more specifically the aims of mathematical teaching than the first three, but are placed among the general aims because their accomplishment depends upon the general mathematical course rather than upon the specific topics covered in the junior high school program.

The specific aims give definite formulation to those mathematical abilities which the junior high school can be reasonably expected to train. Since the recent investigations and measurements of arithmetical ability in the schools show that accuracy is largely due to practice, we may justly expect the junior high school to aim to produce a fair degree of accuracy in computation. And since these same investigations show that speed is largely acquired through maturity coupled with practice, we feel justified in making the second specific aim "reasonable speed in computation without sacrificing accuracy." The development of a definite idea of number values will, it is hoped, enable the pupil to appreciate the difference between the height of an ordinary dwelling house and the height of a down-town business block. This ability to attach the proper approximate number values to the things of everyday life is an important one to develop before the pupil leaves school; or, if he is to continue in school, to develop at an early stage of his mathematical training. The ability to appreciate the degree of accuracy possible in measured data has been left very much in the background in early mathematical courses. Most of us, even yet, feel a little guilty when we use three and one seventh instead of 3.14159 in computing the number of feet of lumber in a round table. The term "significant figures" is, perhaps, the reason for some of the fear prevalent in attacking the subject of measured data; but there can be no doubt that the simple idea involved in the fact that the answer cannot tell exactly how many thousandths of square inches we have when the original data told only the number of whole inches in the dimensions, is an important idea in the applications of mathematics and one which is within the grasp of the junior high school pupil. The term "significant figures" need not be used. The only important thing to be made clear is that there is a limit to the accuracy which can be obtained in any measurement made with a material instrument.

II. Discssion of Topics.

The committee decided that the following topics should appear in the junior high school course in mathematics.

Opposite each topic is placed a letter and number, or several of these, to indicate the aims which can be furthered by the study of that topic. It will be seen that each topic is thus justified by at least three aims.

First Year.

1. Review of fundamental operations of arithmetic. (A2, A3, A4, B1, B2.)
2. Measurement of straight lines, angles, and plane rectilinear figures. Drawing to scale. Straight line graphs. (A5, B3, B5.)
3. Equations: (*a*) $bx=c$; (*b*) $\frac{x}{a}=b$; (*c*) $\frac{b}{c}=\frac{x}{a}$ (ratio). (A1, A2, A3, B5.)
4. Percentage: (*a*) Finding what part one number is of another;
    (*b*) Finding percents of given amounts;
    (*c*) Applications—single discount, simple interest, commission. (A1, A4, A5, B1, B5.)
5. Mensuration: (*a*) Formulas for the areas of rectilinear figures and circles;

(*b*) Rectangular and circular graphs. (A4, A5, B1, B3, B5.)

Second Year.

1. Review of fundamental operations of arithmetic applied to business transactions. (A2, A3, A4, B1, B2.)
2. Percentage: (*a*) Finding base, percentage and rate given.
   (*b*) Applications—successive discounts, interest, notes, savings banks. (A4, A5, B1, B2, B5.)
3. Arithmetic of the home, of the farm, and of civic life. Taxes and insurance. (A3, A4, A5, B5.)
4. Plane geometrical figures—construction and classification of lines, angles, triangles, and quadrilaterals; graphical representation of statistics using squared paper. (A4, A5, B5.)
5. Formulas: (*a*) Perimeters and areas of plane figures including a review of equations.
   (*b*) Square root, Pythagorean theorem.
   (*c*) Surfaces and volumes of solids. (A2, A4, A5, B5.)
6. Equations: (*a*) $ax \pm b = c$, $ax \pm b = cx \pm d$.
   (*b*) Pairs of linear equations. Graphs. (A1, A2, A3, B5.)

Third Year.

1. Percentage (profit on selling price, per cent. error).
   Appriximate computation (square root). (A3, A4, B3, B4.)
2. Construction and evaluation of formulas. Metric measurements. (A1, A5, B5.)
3. Linear equations (review of types of second year, applications from geometry). (A1, A5, B1.)
4. Algebraic expressions (positive and negative numbers, addition and subtraction of polynomials, parenthases). (A1, A5, B5.)
5. Multiplication and division of algebraic expressions (monomials and binomials for multipliers and divisors). (A1, A5, B5.)

6. Factoring: $am + bm + cm$; $a^2 - b^2$; $a^2 \pm 2ab + c^2$; $a^2 \pm 2ab + b^2 - c^2$; $x^2 + bx + c$; $ax^2 + bx + c$. (A1, A2, B5.)
7. Quadratic equations: (*a*) Solution by factoring. Applications from geometry.
    (*b*) Solution by completing the square. (A1, A4, B4, B5.)
8. Ratio (ratios of line segments, or areas, of volumes, sine ratio and tangent ratio). Variation (simple problems in direct variation). (A4, A5, B5.)
9. Variables—Pairs of equations.
    (*a*) Graphs of linear pairs.
    (*b*) Solution of linear pairs by addition and subtraction.
    (*c*) Graphs of linear-quadratic pairs.
    (*d*) Solution of linear-quadratic pairs. (A1, A5, B5.)
10. Fractional equations (monomial and binomial denominators of first degree). (A1, A4, B5.)
11. Properties of plane geometric figures informally developed (lines, angles, triangles, and quadrilaterals). (A1, A4, B5.)

III. ARRANGEMENT OF TOPICS.

After several rearrangements of the above topics, it was decided that the order here given was a suitable teaching order. Although the committee does not feel that the order adopted is the only order possible for these topics, it does feel convinced that the purpose of the course can be most effectively carried out by this order, and that any material change would be liable to defeat the orderly development of the whole plan as a unit.

IV. LIMITATIONS AND INTERPRETATION OF TOPICS.

The topics as given in the outline may suggest to some teachers more than is really intended by the committee. A few cases of such limitations may be mentioned.

1. Each of the four fundamental operations of arithmetic should be checked.

2. Numbers involving decimals should not, as a rule, be carried beyond the third decimal place, or, if significant figures are used, not beyond the fourth significant figure.

3. Mental estimates of results should be made before the results are computed.

4. There should be no abstract problems in denominate numbers.

5. Selling price as a basis of figuring per cent. profit is used by business houses, and the committee strongly recommends this method.

6. No discussion of stocks and bonds nor compound interest should be given.

7. The treatment of discount should not involve the reduction of several discounts to a single discount.

8. The treatment of taxes should be limited to the finding of taxes on property.

9. Problems in insurance should involve finding the premium only.

10. Per cent. errors should be computed from measured and from counted numbers.

11. In the second year, linear pairs should be limited to equations not involving negative numbers.

12. We recommend that in problems involving the removal of parentheses, only one parenthesis within another he used.

13. We recommend the use of a table of square roots for evaluating the roots of quadratic equations.

14. We also recommend the following methods: Horizontal addition to be used from the beginning; Newton's method of extracting square roots.

The committee is aware that the program here laid out will require teachers well trained in mathematics. It must be remembered, however, that the junior high school is to contain the first present high school grade, and that in order to offer this grade instruction of as high an order as it is now getting, we must provide teachers as well trained as those now teaching in this grade. If this is to be done by resorting to the normal schools for the supply, these schools must offer training in mathematics beyond one year of high school algebra which is now the limit of this training in most normal schools. If, however, the school committees and superintendents will insist upon having college trained teachers for the junior high schools, the problem will be solved, and we can hope to have the program here outlined effectively carried out.

A. LAURA BATT,
English High School, Somerville, Mass.
JOHN F. GANNON,
Assistant Superintendent of Schools,
Worcester, Mass.
FREDERICK W. GENTLEMAN,*
Mechanic Arts High School, Boston, Mass.
ANNA W. NEWELL,
Gates Lane School, Worcester, Mass.
FREDERICK E. NEWTON,
Philips Academy, Andover, Mass.
HENRY M. WRIGHT,
English High School, Boston, Mass.
HARRY D. GAYLORD, *Chairman,*
Browne and Nichols School,
Cambridge, Mass.

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* Died December 19, 1918.